Technical Report SERDP-97-12
October 1997

US Army Corps of Engineers
Waterways Experiment Station

Strategic Environmental Research and Development Program

Species Profile: Cerulean Warbler (*Dendroica cerulea*) on Military Installations in the Southeastern United States

by Darrell E. Evans, Richard A. Fischer

Prepared for Headquarters, U.S. Army Corps of Engineers

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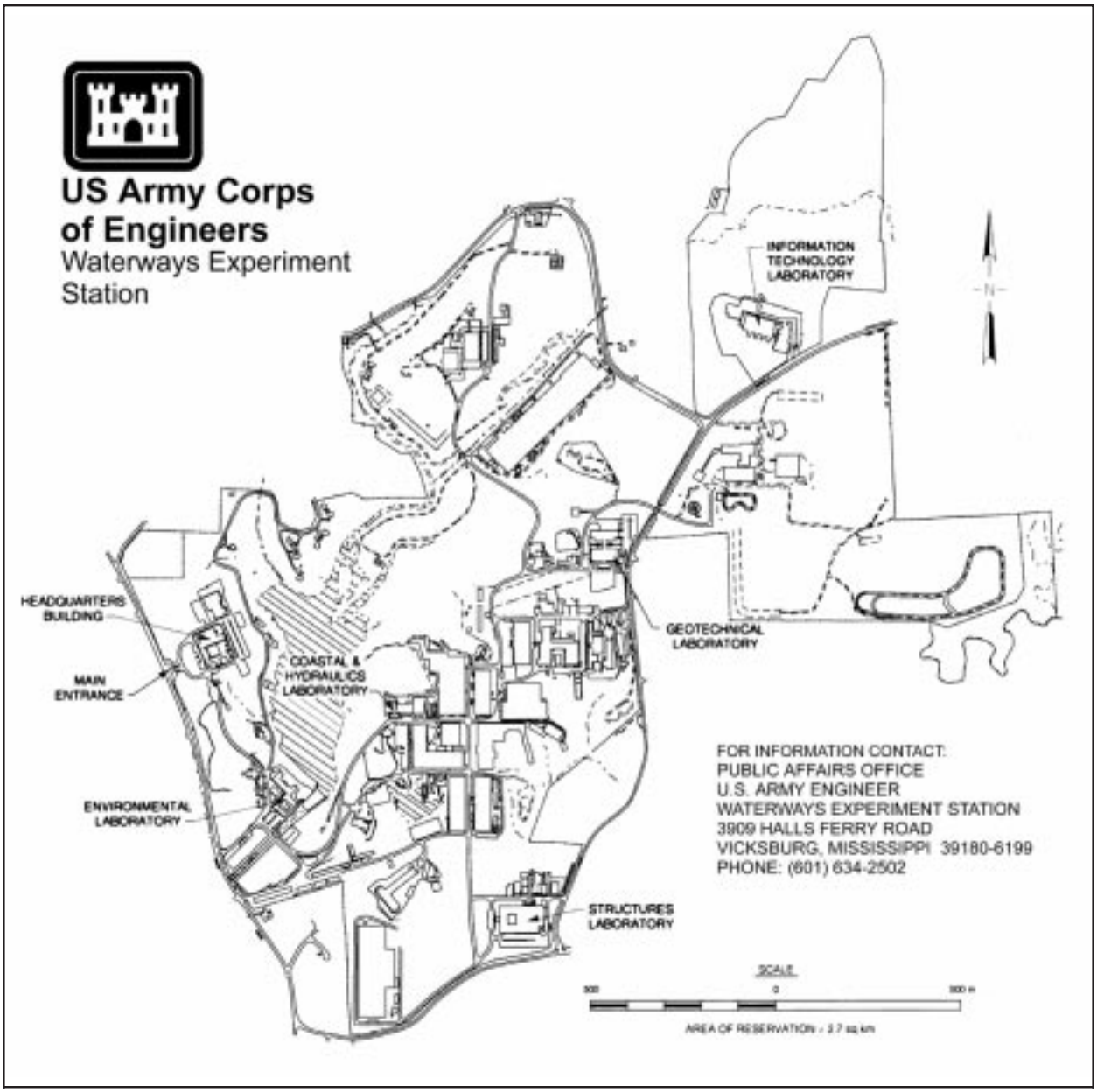
U.S. Army Corps of Engineers
Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Final report

Prepared for U.S. Army Corps of Engineers
Washington, DC 20314-1000



Waterways Experiment Station Cataloging-in-Publication Data

Evans, Darrell E. (Darrell Edward), 1957-

Species profile : Cerulean warbler (*Dendroica cerulea*) on military installations in the Southeastern United States / by Darrell E. Evans, Richard A. Fischer ; prepared for U.S. Army Corps of Engineers.

23 p. : ill. ; 28 cm. — (Technical report ; SERDP-97-12)

Includes bibliographic references.

1. Cerulean warbler — Speciation — United States. 2. Dendroica — Speciation — United States. 3. Birds — Speciation — United States. I. Fischer, Richard A. (Richard Alvin), 1964- II. United States. Army. Corps of Engineers. III. U.S. Army Engineer Waterways Experiment Station. IV. Strategic Environmental Research and Development Program (U.S.) V. Title. VI. Series: Technical report (U.S. Army Engineer Waterways Experiment Station) ; SERDP-97-12.

TA7 W34 no.SERDP-97-12

Preface

The work described in this report was authorized by the Strategic Environmental Research and Development Program (SERDP), Washington, DC. The work was performed under the SERDP study entitled "Regional Guidelines for Managing Threatened and Endangered Species Habitats." Dr. John Harrison was Executive Director, SERDP.

This report was prepared by Mr. Darrell E. Evans and Dr. Richard A. Fischer, Natural Resources Division (NRD), Environmental Laboratory (EL), U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, MS.

Report review was provided by Dr. Paul B. Hamel, U.S. Department of Agriculture, Forest Service, Stoneville, MS; and Dr. David J. Flaspohler, Department of Wildlife Ecology, University of Wisconsin, Madison. WES technical review was provided by Messrs. Chester O. Martin and John L. Tingle, EL. Mr. Martin, WES, and Ms. Ann-Marie Trame, Land Management Laboratory, U.S. Army Construction Engineering Research Laboratories, were Primary Investigators for the work unit. Messrs. Larry Reynolds and Chalin B. Street and Ms. Tiffany Cook, WES, provided valuable assistance in assembling species information.

This report was prepared under the general supervision of Dr. Michael F. Passmore, Chief, Stewardship Branch, NRD; Dr. Dave Tazik, Chief, NRD; and Dr. John Harrison, Director, EL.

At the time of publication of this report, Dr. Robert W. Whalin was Director of WES. COL Robin R. Cababa, EN, was Commander.

This report should be cited as follows:

> Evans, D. E., and Fischer, R. A. (1997). "Species profile: Cerulean warbler (*Dendroica cerulea*) on military installations in the southeastern United States," Technical Report SERDP-97-12, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Species Profile: Cerulean Warbler
(Dendroica cerulea)

Photo by Bill Dyer; courtesy of VIREO©, Cornell Laboratory of Ornithology

Taxonomy

Class . . . . . Aves
Order . . . . . Passeriformes
Family . . . . . Parulidae
Genus/species . . . . . *Dendroica cerulea*
Other Common Names . . . . . None known

Description

Cerulean warblers are small wood warblers (10 to 13 cm (3.9 to 5.1 in.) in length) that breed primarily in mature, floodplain forests of eastern North America. The species is a neotropical migrant that breeds in North America but winters in South America. Males are light blue-gray above with streaked (black-gray with white) underparts and sides. A dark, sometimes incomplete, horizontal bar is present on the upper chest, and white wing bars are obvious on both sexes. Coloration in females is usually more subdued than that of males. The head and upper back of females are dull, blue-gray or bluish green, becoming olive-green on the lower back. Females have a pale whitish eye stripe, and the undersides are dull white with an olive-yellow tinge. Immature birds are similar to females but are more greenish above and more yellowish below. The cerulean warbler is one of the smallest of the wood warblers. Adults are 11 cm (4.3 in.) long, and mean

weight is 9 g (0.3 oz) (n = 36) (Clench and Leberman 1978). The song has been described as being energetic and rapid with three to five introductory short, chanted notes ending with a higher, drawn-out single note.

Status

Legal designation

Federal. The cerulean warbler was a candidate species (C2) for listing as either threatened or endangered by the U.S. Fish and Wildlife Service (USFWS). However, the USFWS discontinued the designation of C2 species as candidates for listing (50 CFR 17; 28 February 1996). The cerulean warbler is considered to be a species of concern, but more biological research and field studies are needed to resolve its conservation status. The species is ranked globally as a G4 species (currently widespread and probably globally secure at present) by The Nature Conservancy (Central Scientific Database, Arlington, VA) (Flaspohler 1993).

State. Several States, including Wisconsin, New York, New Jersey, and North Carolina have classified the cerulean warbler as significant, threatened, sensitive, or rare, but full regulatory protection has not been granted.

Military installations

See Table 1.

Distribution and numbers

The cerulean warbler population has been declining at an average annual rate of 3.4 percent since 1966 (unpublished Breeding Bird Survey data) and has experienced the greatest decline in numbers of all the North American warbler species (Robbins et al. 1992). This species breeds from southern Ontario and southwestern Quebec south through eastern Minnesota, southern Wisconsin, southern Michigan, western and southeastern New York, northwestern Vermont and Connecticut, northern New Jersey, and Delaware south to eastern Maryland and eastern Virginia, and North Carolina. The birds' presence has also been documented in southeastern Nebraska, northern Iowa, eastern Oklahoma, and north-central Texas during the breeding season. Breeding has been reported as far south as southern Arkansas, northern Louisiana, central Mississippi, and northern Alabama and Georgia (Figure 1 shows the potential breeding range in the southeastern United States). The breeding range of cerulean warblers has expanded in several regions of the United States (northeast and south) in recent years in spite of a downward trend in the overall population growth (Brooks 1940, Hamel 1992a). Hamel (1992a) suggested that the increase in breeding range was a direct result of an increase in available habitat resulting from the maturation of previously logged forests.

Table 1
Known Status of Cerulean Warblers on Military Installations in the Southeastern United States

Status	Installation	Status on Installation
AL	Fort Rucker	Potential stopover habitat.
	Fort McClellan; Pelham Range	Potential; "This species nests in tall trees, most frequently near streams. It was not detected during this study" (Alabama Natural Heritage Program 1994).
	Anniston Army Depot	Potential stopover habitat.
AR	Camp Robinson	Documented onsite.
FL	Eglin Air Force Base (AFB)	Potential stopover habitat.
	Avon Park Air Force Range	Documented onsite during migration (rare)
	Tyndall AFB	Potential stopover habitat (Stephen Shea, Personal Communication, 1996).
	Camp Blanding	Potential stopover habitat.
GA	Fort Gordon	Potential stopover habitat.
	Fort Benning	Potential stopover habitat.
NC	Marine Corps Base Camp Lejeune	Potential stopover habitat.
	Marine Corps Air Station Cherry Point	Potential stopover habitat.
	Sunny Point Military Ocean Terminal	Potential stopover habitat.
	Fort Bragg	Potential stopover habitat.
LA	Louisiana Army Ammunition Plant	Potential stopover habitat.
SC	Fort Jackson	Potential stopover habitat.
VA	Fort Lee	Potential stopover habitat.
	Fort Pickett	Documented onsite (Alan Dyck, Personal Communication, 1996).
	Fort A. P. Hill	Potential breeding and stopover habitat.

Ecological Associates

Mossman and Lange (1982) listed eight bird species (ecological associates) that regularly occurred in areas used by breeding cerulean warblers. These included blue-gray gnatcatchers (*Polioptila caerulea*), ruby-throated hummingbirds (*Archilochus colubris*), yellow-throated vireos (*Vireo flavifrons*), barred owls (*Strix varia*), red-bellied woodpeckers (*Melanerpes carolinus*), Canada warblers (*Wilsonia canadensis*), veerys (*Catharus fuscescens*), and warbling vireos (*V. gilvus*). Other species that may potentially occur in areas frequented by breeding cerulean warblers include, but are not limited to, the red-eyed vireo (*Vireo olivaceus*), Northern parula (*Parula americana*), yellow-throated warbler (*Dendroica dominica*), pine warbler (*D. pinus*), and black-throated green warbler (*D. virens*) (Lynch 1981, Hamel 1992a, Robbins et al. 1992).

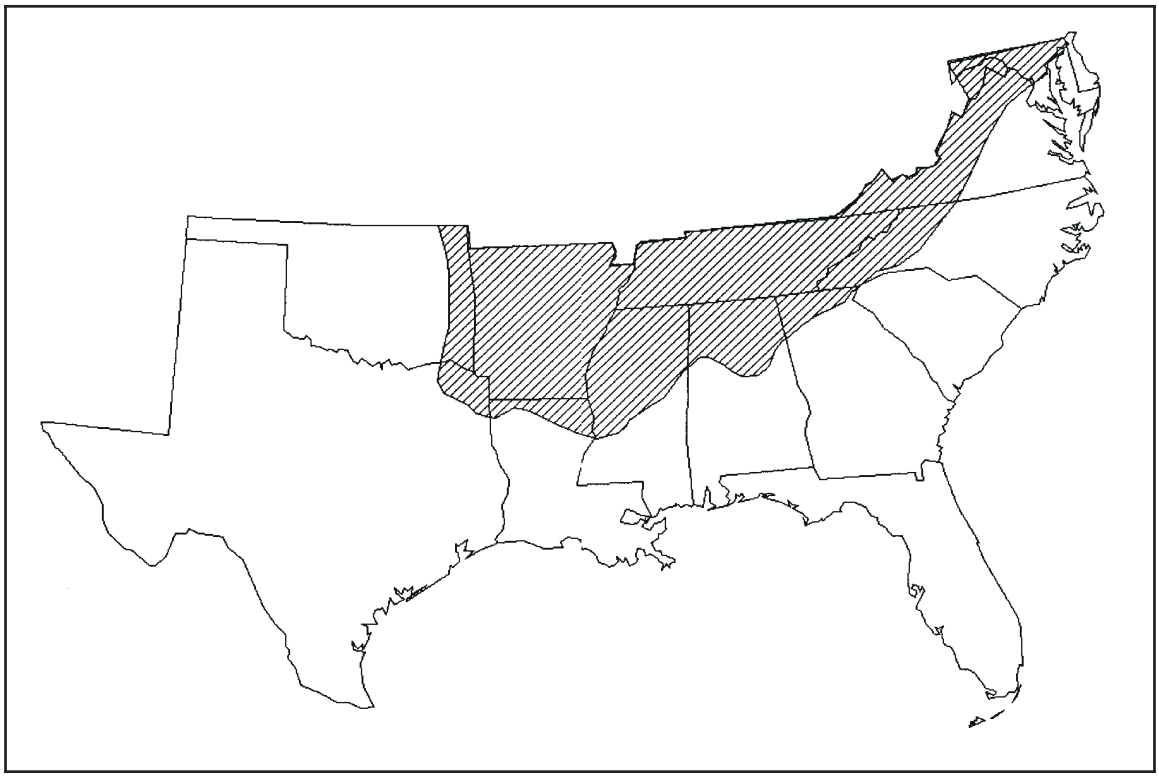


Figure 1. Potential breeding distribution of the cerulean warbler in the southeastern United States (from Robbins et al. 1992, Hamel 1992b)

Life History and Ecology

Cerulean warblers are secretive, and less than 1,000 individuals have been banded since 1950 (Robbins et al. 1992). Several studies have documented that the cerulean warbler is an inhabitant of the upper canopy (Hamel 1992a). Hamel (1981) reported that they were most often observed in the top half of trees, but usually not at the very top. Scientific studies on the life history of cerulean warblers are limited. Thus, the life history (e.g., timing of migration, preferred habitat, food habits, home range size) is poorly understood. This lack of documented information is due in part to the scarcity of the species and its tendency to remain near the tops of large trees on both the winter and summer ranges (Robbins et al. 1992).

Migration

Most birds return from South American winter range to the breeding range in the United States during April and May (Barger et al. 1988, Robbins 1991). During the fall migration, cerulean warblers are one of the first neotropical migrants to reach the Gulf States (Robbins et al. 1992). Southward migrating cerulean warblers have been observed along the coasts of Louisiana and Mississippi as early as mid-July (Stoddard 1917, Burleigh 1944) and in south Florida as early as 21 July (Stoddard and Norris 1967).

Breeding and nesting

Cerulean warblers have been reported to nest in a variety of trees, but oaks (*Quercus* spp.), elms (*Ulmus* spp.), and American sycamore (*Platanus occidentalis*) appear to be preferred (Smith 1893, Mengel 1965, Harrison 1975, Graber et al. 1983, Peck and James 1983). Historical nesting records indicated that American chestnut (*Castanea dentata*) may also have been used for nesting (Peck and James 1987). Cerulean warblers in Delaware have been reported to nest in white ash (*Fraxinus americana*) and osage orange (*Maclura pomifera*) (Linehan 1973). The nests are shallow, cuplike structures made of finely woven grass, plant stems/fibers, tree bark, mosses, and lichens (Harrison 1975, Flaspohler 1993). Nests are lined on the inside with plant fibers and moss and are bound together on the outside with spider silk (Harrison 1975). They are most often placed 3 to 6 m (10 to 20 ft) off the main trunk at the end of horizontal limbs that are at least 6 to 18 m (20 to 60 ft) from the ground (Flaspohler 1993). Nest height varies greatly, but most are located from 8 to 12 m (26 to 40 ft) high (Forbush 1929, Bent 1963, Peck and James 1983, Robbins et al. 1992, Flaspohler 1993). Mean nest height may be underestimated in the scientific literature due to the difficulties associated with locating nests in the crown of tall, deciduous trees. For example, Paul Hamel (Personal Communication, 1996) documented nests ≥30 m (98 ft) above ground in tall forests.

Nesting ecology and behavior (i.e., nest construction, timing, parental care) and reproduction (i.e., number of eggs per clutch, number of clutches per year, age to sexual maturity, success) are poorly understood for cerulean warblers, and little information is available in the scientific literature. Harrison (1975) reported that average clutch size is four and ranges from three to five. Incubation lasts approximately 12 days, and chicks are fledged within 9 to 10 days of hatching. The female is responsible for incubation, but males and females share in feeding the nestlings (Flaspohler 1993).

Density

Density of breeding cerulean warblers varies depending on habitat type and region. From 1937 to 1971, highest breeding densities recorded were in the Cumberland Plateau region of southern West Virginia, eastern Kentucky, and eastern Tennessee (Robbins et al. 1992). The highest recorded breeding density was 290 pairs/square kilometer (750 pairs/square mile) in a climax deciduous forest in Hamilton County, Ohio (Robbins et al. 1992). Harrison (1961, in Robbins et al. 1992) reported densities of 206 pairs/square kilometer (560 pairs/square mile) in a mature oak-hickory forest in Wetzel County, West Virginia. Whitcomb et al. (1981) reported that cerulean warblers have a life expectancy of 12 years.

Home range and movements

Although males are territorial during breeding season, insufficient information was available in the literature to report home range.

Foraging and food habits

Foraging habits were described by Lynch (1981) as "systematically hopping along the upper branches from the main trunk outward to the smaller, peripheral branches, gleaning the underside of leaves and twigs." Cerulean warbler food habits are poorly known but are believed to include adult and immature insects (Butler 1898, Southern 1962, Bent 1963). Howell (1924) reported on the stomach contents of four specimens collected in Alabama and indicated that hymenopterans (unspecified), coelopterans (beetles and weevils), and lepidopterans (caterpillars) were consumed in varying proportions. Boyd (1986) found adult birds in Kansas feeding caterpillars (unspecified), mosquitoes, and flies (Diptera) to their young. Other studies reported that cerulean warblers feed on ants, wasps, beetles, sawflies, caterpillars, and locusts (Imhoff 1962; Hands et al. 1989; Aughey 1878, in Flaspohler 1993).

Habitat Requirements

Breeding cerulean warblers prefer, and are most common in, large and contiguous forested tracts (Hamel 1992a). In Wisconsin, Bond (1957) reported most observations of cerulean warblers in stands larger than 16.2 ha. Robbins et al. (1992) reported highest densities in woodlands at least 1,214 ha (3,000 acres) in size.

Tree diameter at breast height (DBH) appears to be an important criterion for habitat selection by breeding cerulean warblers. Territories are most often located in timber stands where a majority of the trees are in the larger diameter classes. For example, breeding habitat in a Missouri study was most often located in timber stands with a high, closed canopy (>85 percent cover and never <65 percent), and where most trees were greater than 30-cm (12-in.) DBH (Kahl et al. 1985). Subcanopy closure was classified as intermediate to closed (always >45-percent cover) and preferred habitats had an intermediate number of smaller sized woody stems <2.5-cm (1-in.) DBH (1,030 to 2,800 stems/hectare).

In Virginia, Lynch (1981) reported that the highest cerulean warbler densities occurred in well-drained old-growth floodplain forests within 330 m (1082 ft) of the Roanoke River. The overstory canopy in the study area was dominated by sugarberry (*Celtis laevigata*), American sycamore, and green ash (*Fraxinus pennsylvanica*). Highest densities occurred in stands with a high (24.4- to 30.5-m (80- to 100-ft)) closed canopy, distinct shrub layer, and almost complete ground cover. Adult males typically selected the tallest trees available for singing perches. Large, even-aged tracts with little or no old growth contained few, if any, breeding cerulean warblers.

Brewer et al. (1991) reported that cerulean warblers in Michigan were observed in upland stands of beech (*Fagus* spp.), maple (*Acer* spp.), oak, black walnut (*Juglans nigra*), and black locust (*Robinia pseudoacacia*). Butler (1884) (in Flaspohler 1993) reported observing cerulean warblers in Indiana river bottoms and upland hillsides. In Wisconsin, Schorger (1927), and DeJong (1976) reported cerulean warblers in moist woodlands in

both upland and bottomland forests. Stoddard (1917) reported that cerulean warblers in Sauk County, Wisconsin, occurred in "large tracts of tall timber, principally hard maple (*Acer* spp.), basswood (*Tilia americana*), and oak, growing on level, and rather swampy ground between the hills." In the Baraboo Hills Region of Wisconsin, cerulean warblers are most often found on mesic or dry-mesic sites in the canopies of mature deciduous stands (Flaspohler 1993). Mossman and Lange (1982) reported that the species was most common around broader streams in large trees along the edge of small, mesic, open areas. Cerulean warblers have been reported to form loose colonies in areas of suitable habitat (Todd 1940, LeGrand 1979).

Winter habitat

The cerulean warbler winters in multispecies flocks within an extremely narrow elevation zone (500 to 2,000 m (1,640 to 6,560 ft)) in the humid, evergreen forests of the eastern slope of the Andean foothills (Hilty and Brown 1986, Ridgely 1989, Robbins et al. 1992). There are few published studies on the winter habitat of the species, but anecdotal observations on the wintering grounds suggest that they use the humid, evergreen, montane forests of eastern Ecuador and Peru and northwest Bolivia. Tropical deforestation may threaten the cerulean more than any other neotropical migrant because of the its dependence on this limited habitat type (Flaspohler 1993). Habitat loss in this area has been extensive in the past 10 to 15 years, and the area is reported to be one of the most intensively developed (e.g., logged, cultivated) regions in the Neotropics (Robbins et al. 1992). The elevational zone most used by wintering cerulean warblers is also the most suitable for human use. Development in this zone is increasing and adds to an already severe habitat fragmentation problem. Fragmentation is severe along the entire length of this zone and has resulted in a series of small, widely scattered, remnant patches of suitable winter habitat in the most inaccessible areas (Robbins et al. 1992).

Migrational stopover habitat

The availability of suitable habitat en route to breeding and wintering grounds where migrants can safely and quickly replenish energy reserves is critical to successful migration (Moore and Simons 1992). Although cerulean warblers may not breed on many southern Department of Defense (DoD) installations, the species may use hardwood stands on these installations as stopover habitat during spring and fall migration. Presumably, cerulean warblers use large hardwood stands as stopover habitat.

Impacts and Cause of Decline

The cerulean warbler population has dramatically declined over the past 50 years. The exact cause and rate of decline are widely debated but are most often attributed to (a) habitat destruction and loss of montane forests in northern South America, (b) the loss of extensive floodplain forests of the central and eastern United States, (c) habitat fragmentation on both the wintering and breeding grounds, (d) widespread change to shorter rotation lengths in the forest industry, (e) loss of preferred tree species (e.g.,

oaks, sycamore, elms) to disease and insects, and (f) nest parasitism by the brown-headed cowbird (*Molothrus ater*) (Mayfield 1977, Graber et al. 1983, Robbins et al. 1992, Flaspohler 1993). Loss of floodplain forests in the United States has resulted in limited nesting habitat for an already stressed population, and the resulting fragmentation and isolation of large tracts of mature deciduous species have isolated the remaining habitat.

Management and Protection

Management of cerulean warbler breeding habitat should focus on (a) creating and protecting large contiguous tracts of mature, deciduous hardwood forests (especially those adjacent to, or containing, riparian zones), (b) identifying and protecting young deciduous hardwood stands (both bottomland and upland) that can be placed into long-term management to provide future habitat, (c) managing existing and potential habitat on uneven-aged silvicultural systems with long rotation periods to allow preferred species to reach maturity (i.e., emphasizing selection cuts (group and individual tree) to favor older trees), (d) preventing the loss of tree species proven to be locally important to breeding cerulean warblers (i.e., oaks, sycamore, green ash), (e) determining abundance of brown-headed cowbirds and identifying and/or monitoring occurrence of cowbird nest parasitism, (f) annual surveys for cerulean warblers within potential habitat during the breeding season, (g) establishing cooperative agreements with Federal, State, and private landowners to identify, conserve, and manage large tracts of existing and potential habitat, and (h) creating educational and public awareness programs that promote a better understanding of cerulean warbler life history, ecology, and habitat requirements. These provisions are discussed below.

Providing large, contiguous tracts of habitat

One of the most important elements of cerulean warbler habitat appears to be the availability of large, contiguous tracts of mature, deciduous hardwood forests (Schorger 1927, Bond 1957, Imhoff 1962, DeJong 1976, Brewer et al. 1991, Lynch 1981, Robbins et al. 1992, Hamel 1992a, Flaspohler 1993). Installation biologists should strive to connect smaller, fragmented hardwood stands to produce larger contiguous tracts that cerulean warblers prefer. Management of potential habitat should be done on a landscape scale and should focus on allowing potential habitat to mature and coalesce into large, contiguous tracts. Aerial photos, stand attribute data, and if available, spatial data contained in Geographic Information System databases can be utilized to identify existing and potential habitat so that long-term, landscape scale management plans can be developed. Because cerulean warblers use forests with a moderate or high degree of vertical structural diversity, disturbances that increase this diversity (e.g., tree-fall gaps caused by flooding, senescence, or windthrow) may improve habitat for the species (Paul Hamel, Personal Communication, 1996).

Uneven-aged forest management

If hardwood (bottomland and upland) forests are included in an installation's commercial forestry program, an uneven-aged silvicultural system should be instituted in areas designated as cerulean warbler management units. Selection cutting (group and individual tree selection) should be emphasized to favor older, larger diameter trees (in closed canopied stands) that are necessary within breeding habitat for cerulean warblers. Paul Hamel (Personal Communication, 1996) stressed the importance of retaining shade-intolerant tree species in the community, which grow in canopy gaps resulting from tree-fall or removal. If conducted properly, selection cutting can be used to produce forest products from these stands and to perpetuate suitable overstory conditions for cerulean warblers.

Timber stand improvement techniques should be used in conjunction with selection cutting to remove diseased, senescent, and poor quality trees from the forest. Such techniques may improve conditions for residual trees preferred by cerulean warblers by allowing better radial growth and canopy development, as well as improving the overall vigor of the installation's forested tracts. However, the needs of other species that require this type of habitat (e.g., cavity nesters, foraging birds and mammals) should also be considered (David Flaspohler, Personal Communication, 1996).

Preventing loss of important tree species

Tree species identified as being important to nesting cerulean warblers should be identified and protected to provide substrates for foraging, nest building, and singing (for territory establishment). Stands containing or dominated by preferred species can be identified using stand attribute data (if available) and put into long-term management programs that protect and perpetuate such species on the installation. However, empirical evidence for tree species preference may simply be a result of the bird's preference for trees of certain size (DBH and height). Therefore, tree size and surrounding tree size-class distribution should be given greater weight in decision making for forest management (David Flaspohler, Personal Communication, 1996).

If stand attribute data are unavailable for forested lands on the installation, reconnaissance-level field inventories of potentially suitable habitat can be done effectively and economically using any one of several existing forest inventory systems. Field inventories should focus on collecting data necessary for characterizing the structural and compositional attributes (i.e., species composition of the dominant overstory species, basal area, height, canopy conditions (percent closure), DBH, understory conditions, etc.) of potential breeding habitat. When tree species preferred by cerulean warblers are targeted for silvicultural operations, the harvest should be planned by foresters and forest wildlife biologists knowledgeable in both the ecology of preferred tree species and of breeding cerulean warblers.

Cooperative agreements

Cooperative agreements between Federal, State, industrial, and private landowners in the area are paramount for the landscape scale management efforts required to preserve and manage cerulean warbler habitat. Federal and State wildlife management areas and refuges, industrial areas (forest product industries), and private landowners with significant land holdings adjacent to the installation should be contacted and informed of installation plans to develop a cerulean warbler management program. Cooperation and coordination can save significant time and effort and could bring the required expertise together to form a more complete, well-balanced management program.

Other management considerations

Fire suppression. Fire suppression in bottomland hardwood stands is important in the management of forests for cerulean warblers. Fire wounds in hardwood stands usually result in decay caused by various pathogenic agents and can result in a complete change in species composition through time (Walker 1972, Walker and Watterston 1972). Uncontrolled fire in bottomland stands also can be detrimental to tree species preferred by cerulean warblers by perpetuating the more fire tolerant, undesirable species.

Cowbird parasitism. Brown-headed cowbirds are relatively easy to identify because of their appearance, large size, and loud nature. However, brown-headed cowbird parasitism on cerulean warbler nests is extremely difficult to detect because of the location and small size of nests (although once a nest is located, it is not difficult to determine whether cowbird eggs or chicks are in the nest (David Flaspohler, Personal Communication, 1996)). Trapping programs aimed at estimating cowbird abundance on the installation can be used (a) to monitor trends in the resident population and (b) to determine if an intensive control effort is needed for the installation. Trapping programs have proved to be valuable assets in the control and reduction of cowbird populations and have been successfully used on Federal, State, and private lands having excessive nest parasitism. However, Paul Hamel (Personal Communication, 1996) suggested that it may be better to search for cerulean warbler nests and identify eggs or nestlings to determine if parasitism is occurring before instituting a costly and time-consuming control program.

Cattle Grazing. Cattle should be excluded from bottomland hardwood stands. Cattle can damage (trample) regenerating hardwoods, browse on stems that provide habitat structure, and cause soil compaction and erosion.

Flooding. Frequent, prolonged flooding in bottomland stands can have a dramatic impact on tree species composition. Stands that are flooded for prolonged periods of time can experience oxygen deficiencies and toxic carbon dioxide levels that will detrimentally impact seedling germination, survival, and growth. Frequency and duration of flooding should be considered when selecting hardwood stands for cerulean warbler management.

Habitat Assessment Techniques

No comprehensive habitat assessment techniques have been developed for the cerulean warbler. However, Evans et al. (1995) developed a qualitative assessment methodology for potential cerulean warbler habitat for use at the U.S. Army Armament Research, Development, and Engineering Center, Picatinny Arsenal (discussed below) (Table 2). Individual stands were evaluated for the suitability and occurrence of eight important habitat components. Variables used in the assessment included (a) canopy height (dominant tree species), (b) DBH of dominant tree species, (c) species composition of the overstory (percent oaks), (d) ground cover (percent of ground covered by green vegetation), (e) percent occurrence of understory species preferred by cerulean warblers, (f) size of stand, (g) number of stems (plain ≤5 cm) per hectare, and (h) the relative suitability of surrounding lands to cerulean warblers.

The following represents a brief discussion of each of the evaluation criteria used in the assessment at Picatinny Arsenal along with a justification for their inclusion in the assessment process.

Canopy height

Previous research on cerulean warbler habitat use has indicated a preference for areas with a high, closed canopy (Imhoff 1962, Hamel 1981, Lynch 1981, Kahl et al. 1985). Data on canopy heights were broken down into five classes weighted to reflect the species preference for stands with high canopies. Stands with higher canopies (within the range prefered by cerulean warblers) were assumed to be more suitable to cerulean warblers and were scored higher than those with lower or less than suitable heights. Stands with a canopy height of 18 m (60 ft) or greater scored a maximum of five points, and those with canopies less than 14 m (45 ft) scored one point.

Diameter at breast height

Cerulean warblers have been shown to favor stands where the majority of the trees are typical of mature floodplain forests (i.e., large-size classes) (Hamel 1981, Kahl et al. 1985). Stand data were examined, and DBH data for dominant tree species in each stand were grouped into five classes with larger DBH classes scoring higher than lower DBH classes.

Species composition of overstory, percent oaks

Oaks have been reported to be an integral component of cerulean warbler breeding habitat. Overstory data were examined to determine the percent occurrence of several oak species (i.e., cherrybark oak (*Q. falcata* var. *falcata*), swamp chestnut oak (*Q. michauxii*), swamp white oak *(Q. bicolor*), white oak (*Q. alba*), and pin oak (*Q. palustris*)) in the overstory. Information in the scientific literature indicated that areas with a significant oak component (75 to 100 percent) in the overstory represented optimum or preferred conditions.

Table 2
Habitat Variables and Scoring Criteria Used in the Assessment of Cerulean Warbler Habitat on the U.S. Army Armament Research, Development, and Engineering Center, Picatinny Arsenal

Variable	Classes	Score	References
Canopy height, ft	>60	5	Hamel 1981, Lynch 1981, Robbins et al. 1992
	55.1 to 60	4	
	53.8 to 55	3	
	44.9 to 53.7	2	
	<44.9	1	
Diameter at breast height, in.	≥10	5	Hamel 1981, Kahl et al. 1985
	7.9 to 10	4	
	5.9 to 7.8	3	
	4.0 to 5.8	2	
	<4.0	1	
Overstory species composition, percent oak	75 to 100	4	Lynch 1981, Peck and James 1983, Brewer et al. 1991
	50 to 74	3	
	25 to 49	2	
	<25	1	
	None	0	
Percent ground covered by vegetation <2.95 ft high	Dense	4	Lynch 1981
	Moderate	3	
	Light	2	
	Sparse	1	
Percent occurrence of preferred understory species (spicebush, buckeye, pawpaw)	75 to 100	4	Lynch 1981
	50 to 74	3	
	25 to 49	2	
	1 to 24	1	
	None	0	
Size of forest tract, acres	>3,212	5	Bond 1957, Hamel 1981, Robbins et al. 1992
	2,470 to 3,211	4	
	1,730 to 2,469	3	
	988 to 1,729	2	
	<988	1	
Number of stems, ≤2.1 in./acre	417 to 1,134	2	Kahl et al. 1985
	>1,134	1	
	<417	0	
Suitability of surrounding land to cerulean warblers	Suitable	1	Robbins et al. 1992
	Unsuitable	0	

Percent ground covered by green vegetation, <0.3 m (1.0 ft)

Lynch (1981) reported that cerulean warblers in Virginia preferred stands with dense ground cover of green vegetation <0.3 m tall. Ground cover data collected by Picatinny personnel had previously been grouped into several descriptive categories during field inventories in 1989 to 1990. These categories included "dense," "heavy," "robust," "moderate," "light," and "sparse." The dense, heavy, and robust categories were aggregated into a single category called "dense." Dense stands were given four points in the assessment process, and stands classified as having moderate, light, and sparse ground cover were given scores of one, two, and three points, respectively.

Species composition of the understory

Three understory species, spicebush (*Lindera benzoin*), buckeye (*Aesculus pavia*), and pawpaw (*Asimina triloba*), regularly occurred in the understory of areas commonly used by cerulean warblers. These tree species occurred in varying proportions in the understory at Picatinny and were used in the habitat assessment process to evaluate the understory component of Picatinny forest stands.

Size

Cerulean warblers appear to prefer large, contiguous tracts of deciduous forests for breeding (Bond 1957, Hamel 1981, Robbins et al. 1992). Stands were divided into five categories based on size with larger stands rating higher than smaller stands. Stands greater than 526 ha (1,300 acres) were considered optimal for cerulean warblers and were given five points in the assessment process. Stands that were between 405 and 526 ha (1,000 to 1,300 acres) were given four points, and stands between 283 and 404 ha (699 to 999 acres) in size were given three points during scoring. Stands ranging from 162 to 282 ha (400 to 699 acres) were considered marginal for cerulean warblers and were given two points. Stands less than 162 ha (400 acres) in size were considered to be too small for cerulean warblers and scored zero.

Number of stems (<2 in.) per acre

Several authors have reported on the density of small stems in areas frequently used by breeding cerulean warblers. Density of stems <2 in./acre was considered an important habitat component by Kahl et al. (1985). At Picatinny Arsenal, number of stems <2 in./acre were grouped into three categories (417 to 1,134, >1,134, and <417) and used in the assessment process. Stands having 417 to 1,134 stems/acre were considered to represent preferred conditions and were given two points in the scoring process. Stands estimated to have >1,134 stems/acre were considered to be less than optimal and were given one point in the assessment process. Stands with <417 stems/acre were not considered to represent potential cerulean warbler habitat and were not scored.

Surrounding lands

The final element used in the assessment of cerulean habitat at Picatinny was the general suitability of land surrounding stands being evaluated as potential habitat for cerulean

warblers. Stands surrounded by suitable or acceptable habitat types were given one point, and those adjacent to unsuitable types (i.e., cantonment areas, open fields, buildings, etc.) were given no points.

Inventory and Monitoring—Census Methods

Annual surveys of existing or potential cerulean breeding habitat should be conducted during the breeding season. To detect long-term trends, survey methodology and timing should be consistent from year to year and should utilize the same sample points as previous years. A variety of techniques are available for sampling woodland birds (e.g., belt transects, point counts). Hamel (1992b) provides standards for conducting point counts in the southeastern United States that have been adopted by the southeastern working group of Partners in Flight (PIF; see below). Personnel, time required, habitat, degree of difficulty, and desired level of accuracy should be considered when selecting a technique. The same technique should be used annually so that statistical analyses may determine significant changes in species abundance and distribution.

As part of the international PIF initiative to conserve neotropical migrant landbirds, many DoD installations have developed, or are in the process of developing, a MAPS (Monitoring Avian Productivity and Survival) program, which is a cooperative effort among Federal, State, and nongovernmental organizations and the bird banders of North America. The goal of this program is to assess population and demographic parameters (e.g., adult population size, postfledgling productivity, recruitment) for a variety of neotropical migrants (DoD 1995). For further information about the DoD Partners in Flight program, contact the DoD PIF coordinator at (202) 685-3447.

If the necessary personnel are unavailable to conduct surveys at the installation level, several Federal, State, and private environmental groups may be available to help conduct annual surveys and analyze survey data. The U.S. Fish and Wildlife Service Office of Migratory Bird Management, State game and fish agencies, and national and local offices of The Audubon Society and The Nature Conservancy can often be utilized to help conduct avian surveys. Expertise from local universities can also be utilized to help conduct surveys.

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Personal Communications

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY ***(Leave blank)***

2. REPORT DATE
October 1997

3. REPORT TYPE AND DATES COVERED
Final report

4. TITLE AND SUBTITLE
Species Profile: Cerulean Warbler (*Dendroica cerulea*) on Military Installations in the Southeastern United States

5. FUNDING NUMBERS

6. AUTHOR(S)
Darrell E. Evans, Richard A. Fischer

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Engineer Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

8. PERFORMING ORGANIZATION REPORT NUMBER
Technical Report SERDP-97-12

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Corps of Engineers
Washington, DC 20314-1000

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT ***(Maximum 200 words)***

The cerulean warbler (*Dendroica cerulea*) is a neotropical migrant wood warbler that breeds in North America and migrates to wintering areas in South America. This species has experienced the greatest decline in numbers of all extant North American warbler species. The cerulean warbler is a former candidate for listing as threatened or endangered by the U.S. Fish and Wildlife Service. Current breeding range includes portions of eastern Canada and most of the northeastern and Atlantic states, but breeding has also been documented in Arkansas, Louisiana, Mississippi, Alabama, Tennessee, and Georgia. Breeding cerulean warblers prefer, and are most common in, large and contiguous hardwood forest tracts. They have been documented on a few military installations in the Southeast and primarily use habitats in the Southeast for migrational stopover habitat. This report is one of a series of "Species Profiles" being developed for threatened, endangered, and sensitive species inhabiting southeastern United States plant communities. The work is being conducted as part of the Department of Defense (DoD) Strategic Environmental Research and Development Program (SERDP). The report is designed to supplement information provided in plant community management reports for major United States plant communities found on military installations. Information provided on the cerulean warbler includes status, life history and ecology, habitat requirements, impacts and cause of decline, management and protection, and inventory and monitoring.

14. SUBJECT TERMS

Cerulean warbler	SERDP
DoD installations	Species profile
Management techniques	Threatened and endangered species

15. NUMBER OF PAGES
23

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED		